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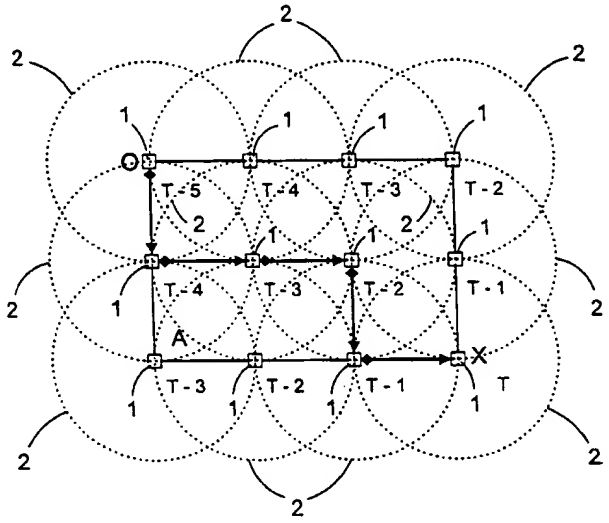
(54) Title: A SYSTEM FOR AUTOMATIC COLLECTION AND TRANSPORT OF READINGS FROM WATER, GAS AND ELECTRICITY METERS



(57) Abstract: The system is characterised in that the at least one transmitter device includes an interface subsystem (3) that adapts the signal from the meter (4) to be processed by a microcontroller subsystem (5), which executes software application and prepares the meter (4) reading to be sent from an RF transmitter subsystem (6) to at least one receiver element (1) that creates a network in an area (A), according to a routing algorithm: A value t is assigned to the receiver elements (1), with 15 maximum value T. If the direct neighbours of a given network node have as a maximum an assigned value t, a value t-k is assigned to this node. Every node will transmit a message to a node with t value larger than its own. If there is more than one with the same maximum value, it will transmit to one of them. The system allows the meter reading to be transported automatically to the billing centre.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A system for automatic collection and transport of readings from water, gas and electricity meters

The present invention relates to a system for automatic collection and transport of readings from water, gas and electricity meters, based on spread-spectrum digital RF communications and Internet protocols. The system allows the meter reading to be transported automatically to the billing centre.

BACKGROUND OF THE INVENTION

Known in the art are systems for taking readings of water, gas and electricity meters, which are based on manual reading of said meters. The usual method involves sending an operative to the building to be invoiced, in order to read and note down the figures of said reading.

This method involves a number of disadvantages which are described below.

The fact of having to go to the building in order to take the reading often means having to gain access to private premises or premises to which it is difficult to gain access. In the case of remote zones, the travel costs of the operative have to be added, and these can be estimated approximately, for Spain, at between 30 and 160 pesetas per reading. To all these disadvantages must be added also the possibility of human error by the operative in taking the reading, together with possible error by the personnel processing the information obtained by the operative.

New electronic reading systems are now being introduced to allow the operative to take the meter readings using a portable computer or the like. Although this system reduces considerably the potential reading error by the operative, it does not solve the problems of

cost associated with the reading, nor does it permit the frequency of readings to be increased. With the intention of reducing costs, the utilities that take the readings from the meters make estimated readings of consumption, that is, they do not take the reading at the residence of the customer but instead determine approximately the reading of the meter, which is unfair for the customer because later, normally at the end of each year, the payment has to be regularised.

The most advanced current systems presently use electronic telemetry emitter systems to send the reading from the meter. Said system requires that an operative use a hand-held receiver to "read" the figures transmitted by the meter, which means that said receiver must be within the coverage range of the transmitter. Although said system does solve some of the disadvantages that have existed so far in relation to the classic manual reading, it still presents several limitations:

- The reading costs are not reduced greatly, since operatives are still needed to travel and take the reading.
- The telemetry systems use narrow-band transmission that can easily suffer interference, and transmission power in the range of tens of watts is required. The system causes 'band pollution' with radio-electric noise and hinders mass deployment thereof in densely populated areas.
- The system works in one direction only, and so cannot carry out other value-added applications.

DESCRIPTION OF THE INVENTION

The device of the invention overcomes the aforesaid disadvantages, while providing other advantages which will be described below.

The system for automatic collection and transport of readings from water, gas and electricity meters is characterised in that the at least one transmitter device includes an interface subsystem that adapts the signal from the meter to be processed by a microcontroller subsystem, which executes a software application and prepares the read data to be sent from an RF transmitter subsystem to at least one receiver element that creates a network in an area, according to a routing algorithm:

- A value t is assigned to the receiver elements, with maximum value T.
- If the direct neighbours of a given network node have as a maximum an assigned value t, a value t-k is assigned to this node, where $k > 0$.
- Every node will transmit a message to a neighbouring node with t value larger than its own. If there is more than one with the same maximum value, it will transmit to one of them.

A system is thereby achieved for automatic collection and transport of readings from water, gas and electricity meters without need for any operative travel, since the reading from the meter is transmitted via radio to the receiver.

Advantageously, the interface subsystem includes an electronic interface capable of adapting the signal pulses sent from a current loop or optical sensor.

This adaptation of the pulses permits correct processing thereof by the microcontroller subsystem.

Also advantageously, the radio transmitter subsystem uses a spread-spectrum digital transceiver capable of implementing a Frequency Hopping or Direct Sequence scheme.

Preferably, the radio transmission subsystem is of low power, such as less than 1W, with a maximum coverage in urban areas of 300 metres.

Since the power is low, this prevents potential interference in the transmission band with radio-electric noise, and thus permits massive deployment in densely populated areas.

According to one characteristic of the invention, the microcontroller subsystem executes the software application on a multi-tasking operating system.

Preferably, the transmission subsystem sends the meter readings to at least one receiver element, via spread-spectrum digital radio and channel sense multiple access method with collision avoidance (CSMA/CA).

The use of spread spectrum considerably reduces the danger of possible interference.

The communication between at least one receiver element and the radio transmission subsystem is bidirectional.

The system is thus capable of sending and receiving information, which means that value-added applications can be implemented.

According to another characteristic of the invention, the communication between said at least one receiver element and the radio transmission subsystem uses the IP protocol.

Moreover, the software application includes a first bidimensional table, in which the first dimension is the tariff to be applied and the second dimension is the identification of the meter read, and a second bidimensional table of tariffs in which the first dimension is the start time and the second dimension is the stop time.

The meters can be substituted by any kind of sensor or data acquisition equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of all that has been outlined, some drawings are attached which, schematically and solely by way of non-restrictive example, show a practical case of embodiment.

Figure 1 shows schematically a digital radio network using FHSS or DSSS by means of an access method to the means based on CSMA/CA deployed in a particular area, by means of which readings of the meters are taken automatically; and

Figure 2 shows a block diagram of the electronic system for automatic collection and transport of readings from water, gas and electricity meters, based on digital radio network with IP protocols, according to the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

An example of the system of the invention is described in the following, by means of which the reading of 1 to 50 metres is carried out, the values of the various readings are stored and are sent to neighbouring equipment 1 which lies within the area of coverage. The deployment of said pieces of equipment in an area A constitutes the network of Figure 1, in which each of the pieces of equipment 1 is able to route the packets of information to one of said pieces of equipment 1, which is called access point.

As Figure 1 shows, the network is deployed in area A. Each circle 2 represents the area of coverage centred upon a system. The area of coverage of a system covers at least one other piece of equipment 1. The bidirectional arrows represent the path travelled by an information packet from a point of origin O to an access point X.

As Figure 2 shows, the system for automatic collection and transport of readings from water, gas and

electricity meters includes an interface subsystem 3 with the meters 4, a microcontroller subsystem 5 and a radio transmission subsystem 6.

The subsystem 1 includes an electronic interface to the water, gas or electricity meters 4, capable of adapting pulses originating from a current loop or optical sensor, for their processing by a microcontroller subsystem 5.

Said microcontroller subsystem 5 is the core of the system and runs a software application on a multi-task operating system. Said software application processes the pulses generated by the meters 4, maintains the values of the various readings and prepares the sending of said readings through the radio transmission subsystem 6.

The radio transmission subsystem 6 includes a digital spread-spectrum transceiver capable of implementing either frequency hopping (FHSS) or direct sequence (DSSS) schemes with digital modulation (i.e., the GFSK, 2GFSK or 4GFSK). The media access protocol (IEEE 802.11 or SWAP-CA) is based on a standard that implements collision sense multiple access with collision avoidance (CSMA/CA). The radio transmission subsystem is of low power, less than 1W, and has a maximum coverage range of 300 meters within urban areas.

The radio transmission is bidirectional, such that the system is capable of sending and receiving information. The transmission/reception operating mode is managed by the software application mentioned above. Said application is also responsible for forming and sending the packets of information according to different network protocols, such as the IP protocol.

Therefore, according to the configuration described, the system works as follows.

When a meter 4 generates a pulse, the interface subsystem 3 generates an interrupt signal to the

microcontroller subsystem 5. The application handles said interrupt and stores the new reading for that meter 4, either as a relative value (increase over the last confirmed dispatch) or an absolute value (total reading since setting into operation of the system).

The software application maintains a bidimensional table of readings, in which the first dimension is the tariff to be applied and the second dimension is the identification of the counter 4 read. The application also maintains a table of tariffs with two ranges: the start time and the stop time.

The software application then sends the readings to a neighbouring device 1, according to a routing algorithm:

- A value t is assigned to the network access points, with maximum value T.

- If the direct neighbours of a given network node have as a maximum an assigned value t, a value t-k is assigned to this node, in which k is an entire number calculated on the basis of neighbourhood link quality.

- Each node will transmit a message to a node with a t value larger than its own. If there are more than one with the same maximum value, it will transmit to one of them randomly selected, in order to distribute the packets uniformly and avoid traffic congestion.

The readings are transmitted as a result of either an external query or a preset sending frequency. The software application may leave pending a confirmation of the sent readings.

The receiver equipment may or may not confirm reception. If it is not itself the data destination it must route the received packet to the final target destination. The application maintains the routing tables to route data packets optimally.

Although reference has been made to one specific embodiment of the invention, it will be obvious to an expert in the subject that the system described lends itself to many variations and modifications, and that all the details mentioned may be replaced by others that are technically equivalent, without departing from the scope of protection defined in the attached claims.

CLAIMS

1. A system for automatic collection and transport of readings from water, gas and electricity meters (4) that includes at least one element to transmit the reading from the meter and at least one receiver element (1) of that reading, characterised in that the at least one transmitter device includes an interface subsystem (3) that adapts the signal from the meter (4) to be processed by a microcontroller subsystem (5), which executes software application and prepares the meter (4) reading to be sent from an RF transmitter subsystem (6) to at least one receiver element (1) that creates a network in an area (A), according to a routing algorithm:

- A value t is assigned to the receiver elements (1), with maximum value T.
- If the direct neighbours of a given network node have as a maximum an assigned value t, a value t-k is assigned to this node.
- Every node will transmit a message to a node with t value larger than its own. If there is more than one with the same maximum value, it will transmit to one of them.

2. System according to Claim 1, characterised in that the interface subsystem (3) includes an electronic interface capable of adapting the signal pulses sent from a current loop or optical sensor.

3. System according to Claim 1, characterised in that the radio transmitter subsystem (6) uses a spread-spectrum digital transceiver capable of implementing a Frequency Hopping or Direct Sequence scheme, with digital modulation.

4. System according to Claims 1 and 3, characterised in that the radio transmission subsystem (6)is of low power, such as less than 1W, with a maximum coverage in urban areas of 300 metres.

5. System according to Claim 1, characterised in that the microcontroller subsystem (5) executes the software application on a multi-tasking operating system.

6. System according to Claims 1, 3 and 4, characterised in that the transmission subsystem (6) sends the meter (4) readings to at least one receiver element (1), via spread-spectrum digital radio and channel sense multiple access method with collision avoidance (CSMA/CA).

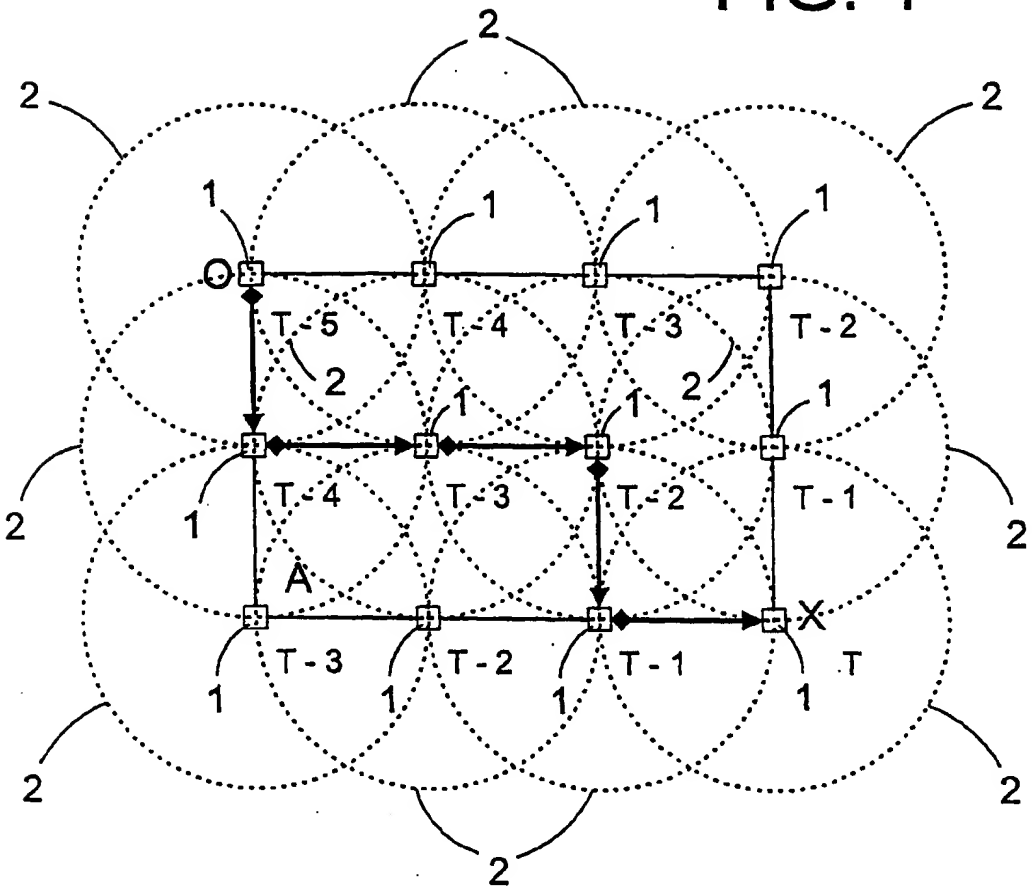
7. System according to any previous claims, characterised in that the communication between the at least one receiver element (1) and the radio transmission subsystem (6) is bidirectional.

8. System according to any previous claims, characterised in that the communication between said at least one receiver element (1) and the radio transmission subsystem (6) uses the IP protocol.

9. System according to any previous claims, characterised in that the application includes a first bidimensional table, in which the first dimension is the tariff to be applied and the second dimension is the identification of the meter (4) read, and a second bidimensional table of tariffs in which the first dimension is the start time and the second dimension is the stop time.

10. System according to any previous claims, characterised in that the meters can be substituted by any kind of sensor or data acquisition equipment.

FIG. 1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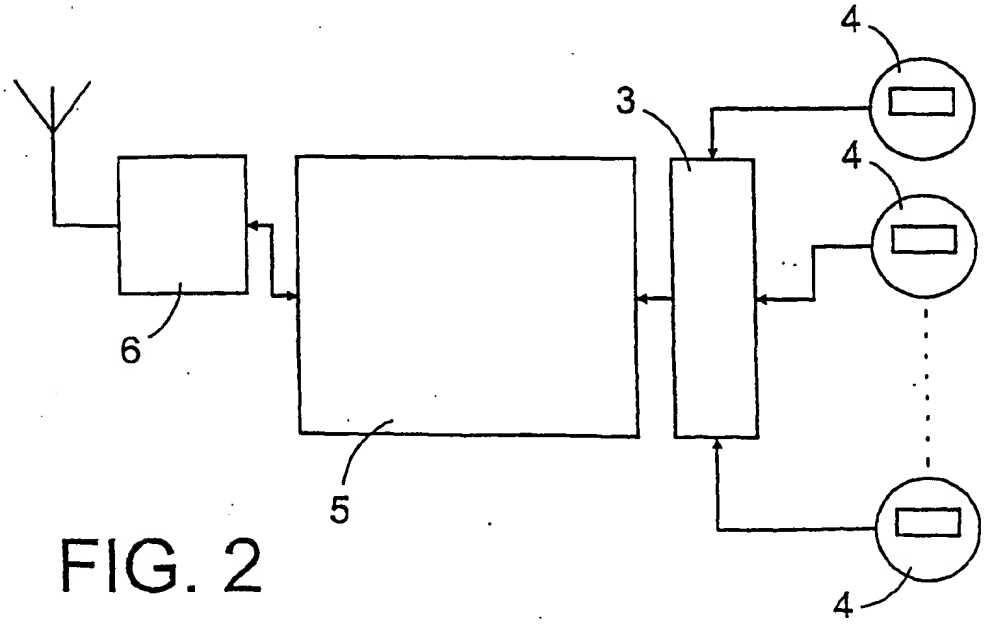
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FIG. 2